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L. O. HOWARD, Chief

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THE PINK CORN-WORM: AN INSECT DESTRUCTIVE TO CORN IN THE CRIB.

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U.S. BUR. ENTOM. 23 MAY 1916

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INTRODUCTION.

For nearly three-fourths of a century the larva of a small moth (*Batrachedra rileyi* Wals.), commonly known as the pink corn-worm (fig. 1), has been found in corn in the field and in store as well as in blasted cotton bolls. It was not, however, until the year 1914 that this species was recognized as a pest. During November and December of that year complaints were made of damage by the pink corn-worm to corn in cribs. The number of complaints was enormous and the damage in Mississippi was so widespread that much alarm was felt in infested districts. The correspondence, which will presently be quoted, shows plainly the extent of the insect's ravages as also the fear that entire crops

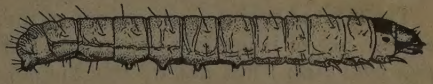


FIG. 1.—The pink corn-worm (*Batrachedra rileyi*): Full-grown larva, lateral view. Enlarged. (Original.)

NOTE.—This bulletin points out the increasing menace of this insect, which has never been considered a serious enemy of grain, but now assumes nearly the same importance as the Angoumois grain moth and is much more troublesome than the European grain moth. It also recommends methods of control. It will prove of interest to farmers in the region extending from South Carolina westward to central Texas, southward to southern Texas, and northward to Arkansas and Tennessee.

of corn in the principal regions infested might be lost. While the insect confined its attacks largely to Mississippi, it was also observed in injurious numbers in Arkansas, Alabama, Texas, and Louisiana.

Singularly, the species was not described until the year 1882, when Lord Walsingham gave it the name of *Batrachedra rileyi*, but it now assumes nearly the same importance as the Angoumois grain moth [1] and is much more troublesome now than the European grain moth.[2] The species sufficiently resembles the latter to have been mistaken for it by Glover and others, and its work has been compared to that of the former. In reality it bears some resemblance to both species in appearance and habits.

The pink corn-worm was first brought to the writer's attention in ripening ears of corn from Texas in 1894 (Chittenden, 1897).[3] From the fact that the larvæ first seen were feeding on the husks and the species was not then identified as feeding naturally on the kernels of corn, it was for convenience called the corn-husk moth, and this name might have been retained had not the insect developed later into a destructive grain-feeding species. The names pink corn-worm, pink worm, and red corn-worm are now in general use in the South.

NATURE OF INJURY.

In material received from Baton Rouge, La., and Beeville, Tex., in 1895, the little rose-colored larvæ were noticed by the writer chiefly between the husks, which were fresh and succulent, and on these they were feeding. A few moths were afterwards reared from the husked ear. The Texas sending afforded a fair opportunity for the study of the work of the species. One undeveloped ear harbored numbers of the larvæ which had gnawed into every part of it from the outer husk to the dwarfed ear within.

The injured grains when examined individually have somewhat the appearance of being infested by the Indian-meal moth (*Plodia interpunctella* Hbn.) but not by the Angoumois grain moth. The larvæ evidently begin to feed on the grains while the latter are still "in the milk" or very soon afterwards, beginning at their insertion and working outward toward the crown. The embryo and surrounding parts are hollowed out and the seed envelope is often eaten away about the base or "tip" of the seed. An astonishing amount of frass is developed which is neither eaten a second time nor packed tightly within the kernel, as is evidently the case with the Angoumois moth larva, but the particles, being loosely joined by webbing, fill the interstices between the kernels. (Pl. I.) Usually a single larva inhabits a kernel but frequently the interior of a grain is completely devoured, so that the only part remaining is the thin outer integument inclosing a varying amount of accumulated frass. Doubtless this is the work

[1] *Sitotroga cerealella* Zell. [2] *Tinea granella* L. [3] See Bibliography, p. 19.

of more than one caterpillar. It will be noted that the caterpillar does not confine itself, as does the Angoumois moth, to the kernel or any part of it, but attacks seed, husk, and cob alike.

While no positive statement can be made as to the cause of the sudden increase of the pink corn-worm, it may, perhaps, be due to the fact that cotton is not cultivated on so large a scale or so universally as in the past, and possibly it may be due to the destruction of the bolls by plowing them under as a remedy against the boll weevil. These practices would naturally have the effect of driving the moths to deposit their eggs on corn, and this acquired taste of the larvæ might in time be transmitted to their descendants. There can be no doubt that when corn is left too long in the field the ears are more easily penetrated by the insects. Often, too, if they are permitted to remain there over long they become moist, and if stored in this condition injury by the pink corn-worm and other insects is greatly hastened. Still another practice favors the multiplication of the moth, namely, storing corn too long in the husk. The layers of husks just under the outer sheath are frequently badly eaten at about the middle, only the longitudinal veins being rejected. On one fully developed ear nearly every kernel was infested and the ear was so completely enveloped in frass and webbing as to be useless for any purpose. Every ear in which this species was found lodged had been first attacked by the corn-ear worm (*Heliothis obsoleta* Fab.). (Pl. I.)

DESCRIPTION.

THE MOTH.

Batrachedra rileyi belongs to the same lepidopterous superfamily [1] as the Angoumois and European grain moths, but to a different family.[2] From either of the others this species may be easily distinguished by its smaller size and by its remarkably slender hindwings and their correspondingly long fringes. The forewings are banded and feebly mottled with yellow, reddish-brown, and black. The antennæ are white, annulated with fuscous, and the legs are banded with fuscous. (See fig. 2.)

The wings measure, when expanded from tip to tip, a little less than half an inch (9–11 mm.).

The moths are very active on their feet and when at rest fold their forewings closely together with their tips "cocked up" after the manner of many other tineids and related moths.

Following is the original description by Walsingham:[3]

Head chestnut-brown; palpi widely divergent, whitish, with an oblique pale brown mark on each side near the end of the second joint, and two or three brownish

[1] Superfamily Tineina.

[2] Family Elachistidae.

[3] Walsingham, Lord.—Notes on Tineidae of North America. *In* Trans. Amer. Ent. Soc., v. 10, p. 198–199, 1882.

spots on the sides of the apical joint. Antennæ with white and fuscous annulations; the basal joint elongate, chestnut brown. Fore-wings chestnut-brown, slightly shaded with fuscous towards the costal margin; a whitish ochreous streak at the base of the dorsal margin, followed by two or three other smaller ones along the dorsal margin (in some specimens these are obsolete); above the dorsal margin are two oblique whitish ochreous streaks, the first before the middle, the second before the anal angle. A similar streak from the costal margin immediately before the apex is outwardly margined by a streak of black scales, the apex and apical margin being also black; there is also a faint fuscous streak running downwards through the cilia below the apex. On the cell are two elongate patches of black scales, one immediately before the middle of the wing, the other halfway between this and the base. Fringes grey, with a slight yellowish tinge. Hind wings pale greyish. Hind tibiæ greyish white, outwardly fuscous; hind tarsi whitish, with a wide fuscous band followed by two fuscous spots on their outer sides. Expanse 11 millim.

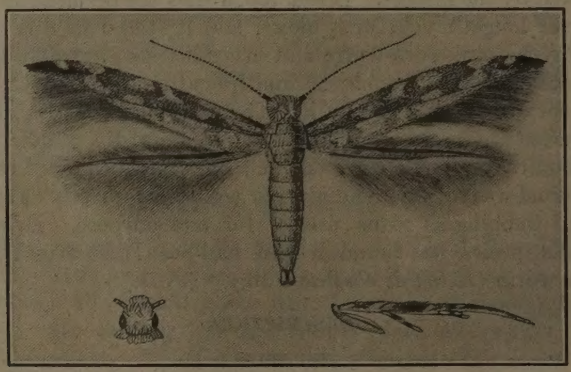


FIG. 2.—The pink corn-worm: Moth, showing head covered with scales; below, at left, head showing eyes at side; below, at right, hind leg. Moth much enlarged, head and leg more enlarged. (Original.)

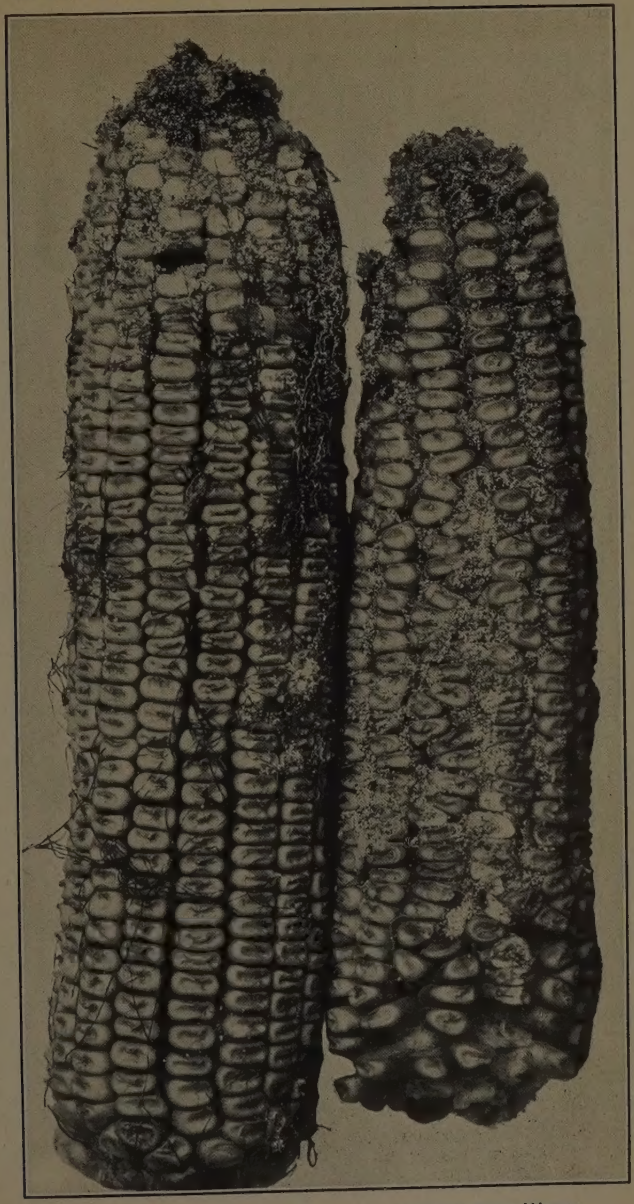
THE EGG.

The eggs of this species resemble considerably those of the Angoumois grain moth (*Sitotroga cerealella*). They have been found deposited on dry corn husks and in such locations are much flattened on the surface, differing in this respect from those of Sitotroga. The egg may be described as follows:

Flattened oval; widest near the middle; truncate at one end and narrowed at the other, with the surface strongly wrinkled, forming coarse, irregular, ridgelike longitudinal lines. As would naturally be expected in a species so much smaller than the Angoumois moth the egg is much smaller, and instead of being red it is pearly white throughout with a perceptible iridescence.

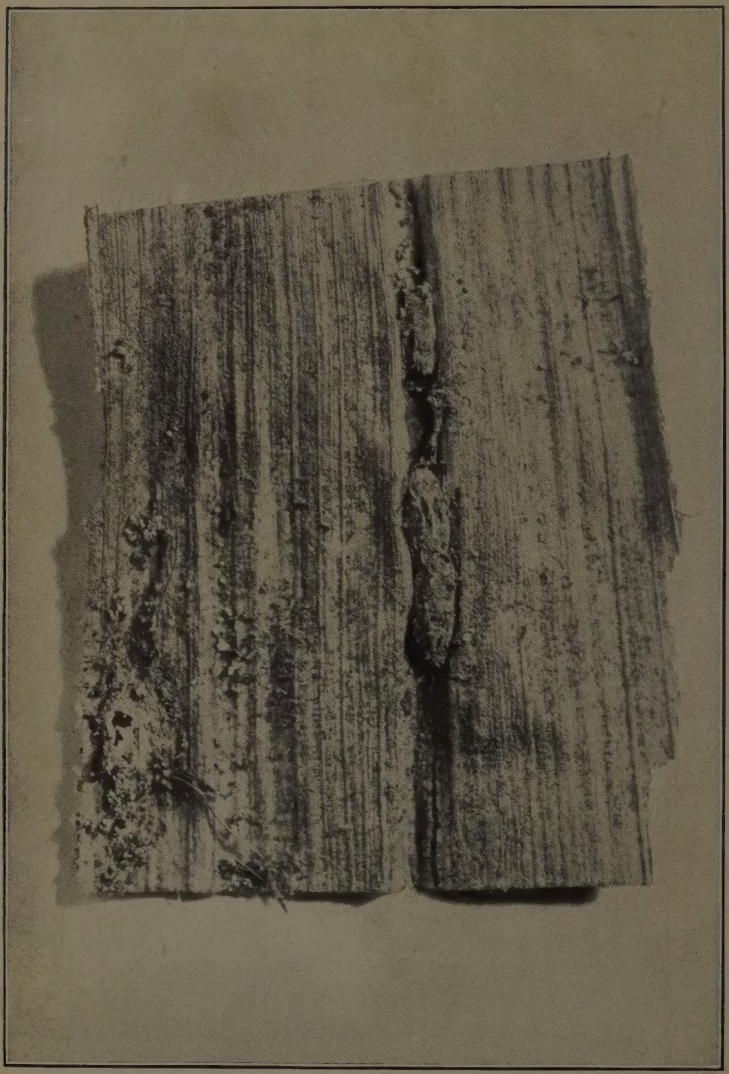
Measurement: Length, 0.4 mm.; width, 0.1 mm.

The eggs are deposited singly or in groups up to three or four. Since they are nearly colorless, not pinkish like those of the Angoumois moth, they are quite difficult to locate with the unaided eye. The egg is illustrated by figures 3 and 4.



WORK OF THE CORN-EAR WORM AND THE PINK CORN-WORM.

Corn ears showing primary injury by corn-ear worm (*Heliothis obsoleta*) at top and additional injury by pink corn-worm (*Batrachedra rileyi*), especially on right ear. (Original.)



COCOON OF THE PINK CORN-WORM ON SECTION OF DRY CORN HUSK, SHOWING A PUPA NEAR TOP AND TWO OVERLAPPING NEAR MIDDLE; ALSO LOCATION OF ONE OR TWO OTHERS AT LEFT. (ORIGINAL.)

THE YOUNG LARVA.

The larva when first hatched is nearly white, but soon becomes pinkish. The head and thoracic plate are darker. It is at this time about 1 mm. in length and quite slender.

FIG. 3.—The pink corn-worm: Eggs, highly magnified. (Original.)

THE FULL-GROWN LARVA.

When full grown the larva of this species bears some resemblance to that of the Indian-meal moth (*Plodia interpunctella*). It is, however, considerably smaller and more slender, and is somewhat flattened by comparison. It may be described as follows:

FIG. 4.—The pink corn-worm: Egg, highly magnified. (Original.)

When fully extended it is about eight times as long as wide. Head quite narrow, in contour nearly identical with that of Plodia; of the same pale brown color, with sutures well marked, and appendages and mouth-parts still darker. Thoracic plate nearly one-third wider than head, well divided at middle; light brown dorsally and dark brown at sides. Thorax and dorsum sparsely covered with concolorous piliferous tubercles with inconspicuous hairs. Body entirely pale carneous or pinkish; lower surface showing slight carneous tint in first two thoracic joints and along the sides. Anal plate quite small, about the same color as the head. Legs whitish and rather short. Prolegs consisting of five pairs. Length, 8 mm.; width, 1.2 mm.

The full-grown larva is illustrated in figures 1 and 5.

The arrangement or pattern of the pink color is shown in figure 5. It appears to be distinctive.

THE PUPA.

Somewhat robust, about three times as long as wide; head subtruncately rounded at apex; eyes large, black, passing under the basal joints of antennæ, showing plainly at the sides and from the back; wing-cases and antennal cases reaching nearly to penultimate segment; segments well-defined, last segment with rounded area near middle and terminating with several short, delicate bristles curved at extreme apices like minute hooks; color yellowish brown.

Length, about 4.5 mm.; width, 1.5 mm.

Figure 6 shows the ventral view of the pupa at the left and the ventral view in outline at the right.

THE COCOON.

The larva spins rather copiously and when fully mature it makes a cocoon of silk, coated somewhat irregularly on the outer surface with frass and other accumulations. A cocoon before the writer measures 7 mm. in length and 2.8 mm. in width, being subcylindrical and a little larger at the end where the head rests than at the anal end. The cocoons vary considerably in appearance, some being much flattened as shown in Plate II. The one described was deposited on a dry husk and partakes of the faded gray color of the latter.

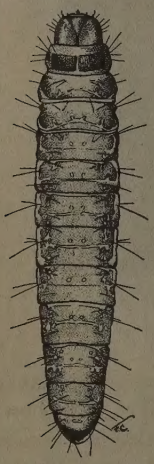


FIG. 5.—The pink cornworm: Full-grown larva, dorsal view. Enlarged. (Original.)

DISTRIBUTION.

As has already been stated, this species has thus far been found most abundantly in Mississippi but it inhabits all of the States bordering on the Gulf, as also Arkansas, Tennessee, South Carolina, and Georgia. (Fig. 7.) The southernmost point from which it has been reported is Brownsville, Tex., and it is without doubt present in Mexico. The most northern point is in Tennessee. The species is also found in Hawaii and may be native to the Orient, although we have no record of this. The probabilities are that it is not indigenous to Hawaii but may be to Mexico and our Gulf States.

RECORDS OF INJURY.

The reports which follow are not verbatim but they give a very good idea of the nature of injury in different localities and the opinions of practical growers in regard to losses and danger of future injuries.

INJURY DURING 1914.

November 9, 1914, Mr. W. B. Thomasson, jr., Murfreesboro, Ark., sent many ears of old, musty corn, badly injured by the pink corn-

worm as evidenced by abundant webbed-up excrement. He stated that this species, together with the rice weevil, whose presence was shown by characteristic holes in the corn, was at that time destroying all corn in the crib throughout the country, and that if not prevented from so doing the "worms" would destroy all the corn there.

November 28, Mr. R. W. Harned, entomologist, Mississippi Agricultural and Mechanical College, Agricultural College, Miss., sent specimens of corn which were badly infested with this small pink larva. He wrote:

During the past few weeks we have received dozens of complaints from correspondents in regard to the damage caused by these insects. Some claim that practically all of their corn has been consumed by these small "pink worms." Many who claim to have raised corn for years state that they have never before seen anything of this kind. Although I have received dozens of samples of these insects I have so far been able to rear only one adult or moth, and I have noticed only one kind of larva. They are these little pink larvæ that make webs wherever they go. In some cases they eat the entire grains.

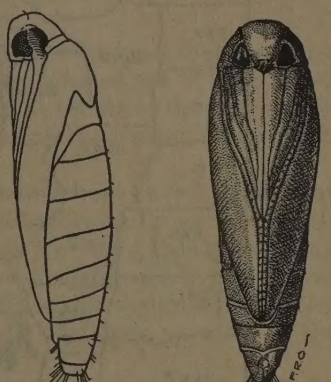


FIG. 6.—The pink corn-worm: Pupa, ventral view at right, lateral view at left. Enlarged. (Original.)

In order to furnish you with an idea as to what farmers in Mississippi think about the pink corn-worm I quote from a few letters on file as they come to me:

Mr. W. M. Taylor, Kilmichael, Miss., wrote, "I am sending specimens of small pink worms which are doing considerable damage in this section to stored corn."

George M. Bates, Union, Miss., wrote, "There is a small worm of a reddish color eating up the corn in the bins. I want to know the origin of this worm and what remedy to use to stop its work."

J. H. Rice, Sardis, Miss., wrote, "I have inspected and find a small red worm in every ear of corn. * * * It seems to be eating the corn severely. I have looked at several other places around Sardis and find them in every place."

C. S. Tindall, Winona, Miss., wrote, "I am sending some pink worms found in my corn. Every ear has from 1 to 50 worms and the corn that has *been in the barn longest seems worst infested.* The recent cold weather did not kill them on the corn in the fields."

Jason N. McColl, McColl, Miss., wrote, "Am inclosing small box of worms which are very numerous in everyone's corn in this section."

L. P. Bell, West, Miss., wrote, "We find a small pink-colored worm in our corn. *They enter the grain at the little end next to the cob and eat up the grains.* Some farmers report that cribs of corn have been destroyed in places. Investigation shows that they are in all cribs of corn in more or less quantities and the farmers are becoming very uneasy for fear the entire corn crop will be devoured. They appear to be worse in damaged corn but are found in sound ears too."

G. C. Tucker, Tyro, Miss., wrote * * * "I am sending an ear of corn. You will see how it is damaged. My entire crop is infested with this insect; in fact, it is almost half ruined. I want to crib my corn at once but an afraid to do so in the condition it is in."

M. D. Doss, Dossville, Miss., wrote, "I am sending an ear of corn which has some kind of a worm in it that is eating it up. It is a very small pink-looking worm. I have heard a great many people in this community talking about this worm in their corn. Please tell me what it is and how to get rid of the same."

W. H. Ellard, Kosciusko, Miss., wrote, "Would like to know what to do for my corn. I find a small pink worm about the size of a large needle. They seem to work from top to butt. Would like to know what to do to destroy them at once. I have 600 bushels infested this way."

W. L. Synnott, Embry, Miss., wrote, "The corn in this section is infested with a small pink worm which seems to be doing considerable damage."

J. B. Harris, Stewart, Miss., wrote * * * "I am sending you an ear of corn infested with a worm that I am informed is destroying entire cribs of corn in some sections. Practically all of the corn in this section is more or less infested."

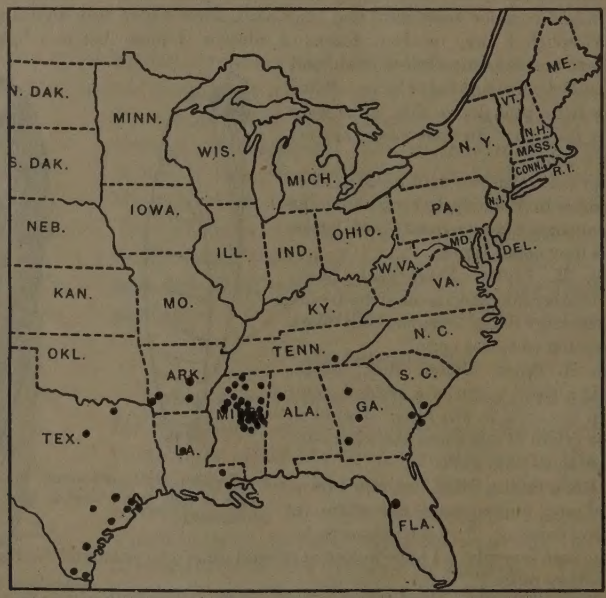


FIG. 7.—Map showing distribution of the pink corn-worm in the United States. (Original.)

L. L. Wilson, Ethel, Miss., wrote, "There is a little red worm eating my corn—doing a lot of damage."

J. W. Johnson, Rio, Miss., wrote, "I am sending you specimens of worms that are eating up everybody's corn in this country."

On December 8, Mr. Harned again wrote in regard to this species, furnishing the following notes concerning correspondence during November:

* * * "From the large number of letters that I have received this pest is undoubtedly most serious in Attala County and the counties immediately joining it. There can be no doubt that this insect is causing an immense amount of damage in this State at the present time. The farmers have become excited about it and many have called me over the long-distance telephone and every mail brings in letters in

regard to it. We find the ears infested in the fields as well as in the cribs. I am sure that they work on sound cobs.

Mr. L. P. Bell, West, Miss., whose letter has just been quoted in brief, wrote:

> Investigation shows that they are in all cribs of corn * * * the farmers are becoming uneasy about the crop. They appear to be worst in damaged corn but are found in sound ears too.

Mr. Thos. H. Jones, who has been working under the writer's direction, makes practically the same statement, and Mr. J. B. Garrett, Assistant Director of the North Louisiana Experiment Station, Calhoun, La., under date of November 24, 1915, wrote as follows:

> It would appear from my observation, which of course is rather limited, that the "pink corn-worm" is found in ears of corn most frequently where they have been previously injured by bollworms, birds, etc., *but I have seen them in ears which were perfectly sound and showed no signs of other injury.*

We must accept this as the truth in spite of the fact that the writer and several others have never seen any infested ear of corn which was not first attacked, if ever so lightly, at the tip of the husk by the bollworm or some other insect, giving ample opportunity for the moth of this species to deposit her eggs.

On December 2 Mr. W. H. Horne wrote from Laurel, Miss., that his community was thrown into considerable confusion by the discovery of a little pink corn-worm which was doing damage to many cribs of corn. As the pest seemed to be comparatively new he was desirous of any information that would enable the growers to stem its ravages. He desired also a personal visit from an agent of the department.

The Bureau of Entomology received later, through Hon. T. U. Sisson, a communication from Mr. W. B. Rainey, Hesterville, Miss., stating that there was a little worm known as the "pink worm" in that country eating the corn after it was cribbed. Information in regard to some remedy was urgently requested. The statement that the insect formed a web at the little end of the ear, and from there proceeded downward eating and webbing, left no doubt that this was the species in question.

On December 5 Mr. R. P. Wright, wrote from Carthage, Miss., amply describing this insect, saying that it threatened to destroy the corn in that vicinity, and that numbers were imbedded in almost every ear of corn, which they ate most voraciously.

INJURY DURING 1915.

During January, 1915, ears of corn showing average infestation of the pink corn-worm were received from Mr. K. H. Diggs, Lexington, Miss.; there were three varieties of corn taken from five different cribs. The corn was planted between April 5 and May 10, and har-

vested in October and November. Mr. Diggs reported that he found the worst damage in immature or imperfect ears where the bollworm or birds had attacked the ear.

During the last days of December, and on January 1, this species was reared from different lots of corn received from Mississippi. One of these localities is Sardis; another is Batesville. The material was received about November 19.

Twenty ears of corn were received on January 7 from Mr. Thos. H. Jones, of the Bureau of Entomology, Baton Rouge, La.; all were imperfect, every ear having been injured and much stunted by the corn-ear worm (*Heliothis obsoleta*). The larval forms of *Batrachedra rileyi* were crawling over the husks of the corn in great numbers, as also on the inside of the bags, seeking a suitable spot for pupation. There were approximately 400 larvæ of various sizes. The larvæ worked on the underside of the grain, especially in the decaying grains or parts of the ears, but the actual damage resulting in this instance was not great. Pupæ were also found in various places—in the husks, beneath the hollow grain, in the cob, and among the castings on the ear. Mr. Jones wrote as follows:

> Larvæ were common in undeveloped and poorly formed ears of yellow flint corn in a field at Baton Rouge, on January 2. The valuable ears had been pulled from the stalks in the fall, the stalks at present being dead and brown and, for the most part, still standing. The larvæ were found beneath the husk, working on the surface of the cob among the remains of the kernels, many of which have never matured.

January 29, Mr. J. J. W. Smith, Waterford, Marshall County, Miss., sent three ears of corn badly infested with the little worms. They were described as doing much damage to the corn.

> They go from one end to the other in the heart of the corn. Shucking the corn out is the best and safest way to save the corn. Cold weather does not seem to have any effect on them while the shuck is on the corn. But when the corn is shucked and knocked about it helps the corn and does not give the worms such a good chance.

February 1, Mr. W. T. McDonald, Bailey, Miss., sent specimens working in corn ears injured by the corn-ear worm, with the statement—

> we attribute the heavy infestation of the worms this season to the extreme dry weather while the corn was making. I find on my place that the corn worst hurt by the drought is worst infested by the "worms." * * * I have never had any experience with the pest prior to the present season, and I may be in error.

Similar complaints were also received of injury to corn from various other localities, as follows: Brownsville, Tex., reported by M. M. High; Lawrence, Union, Saltillo, Harris, Louin, Battlefield, Chunky, Coila, Beach, and Thyatira, Miss.; Fayette, Ala., and Scott, Ark. The insect has been reported by Prof. J. M. Beal, Agricultural College, Miss., to have attacked Kafir corn. During November of 1915 complaint of injury by this species was made at Quitman, Miss.

January 16, 1915, Mr. C. E. Smith collected in the field at Baton Rouge, La., and sent to the writer several cobs of corn in the husk. The cobs were poorly formed, most of them having few developed grains, and they showed old work of the corn stalk-borer (*Diatraea saccharalis* Fab.) and of the corn-ear worm. A number of adults of the rice weevil (*Calandra oryza* L.) were present in the husks, and adults of *Cathartus gemellatus* Duv. were abundant in the same situation.

The pink corn-worm was found among the leaves of the husk, in the kernels, and in the cob itself. Larvæ of various sizes were present, but were mostly nearly full-grown, judging from some that were observed in silken cocoons in all locations where larvæ were observed.

It was difficult in this case to estimate how much feeding had been done on the husks, kernels, and cobs by the Batrachedra larvæ because of the injury by, and the presence of, other insects. Larvæ of *Cathartus gemellatus* and of *Sitotroga cerealella* were also present and may have caused some injury. It seems, however, that a part of the silk and most of the small pellets are due to the work of the Batrachedra larvæ and that some of the cavities in the kernels were due to them.

Messrs. Thos. H. Jones and C. E. Smith found the pink corn-worm in various sizes, some apparently full-grown, working on ears of sweet corn, in company with several other species. In some ears they were working where the husk was still green and in some cases where the husk had begun to dry. The larvæ followed attack by other insects, or where from some other cause a portion of the ear had become exposed as from injury by birds, and "nipping off" of the tips by a horse, etc. In many cases the ears in which they were working were in bad condition, being so injured as to be of little value.

At Baton Rouge, La., on July 24, 1915, moths were placed in a jar containing yellow cornmeal with a piece of sponge moistened in sweetened water, the jar being placed in the insectary. The first moth, coming from eggs laid by moths placed in the jar at this date, was noted on September 30. The time taken for the development would indicate, when compared with the rate of growth on other substances, that cornmeal is not a particularly good food for the larvæ. It will be noted here that it was possible to rear this insect in cornmeal in experiments conducted at Washington. Another point should be made, namely, that infestation in Louisiana has not been anywhere near as severe as in Mississippi, and that most of the corn ears received from the latter State were in exceedingly bad condition.

EARLIER RECORDS.

From correspondents of the Bureau of Entomology we have had this species from Colquitt, Perry, and Atlanta, Ga., and New Orleans, La., in cotton bolls.

In September of 1894 and again in November, 1895, specimens in the several stages, together with ears of corn in which the insect was living, were kindly sent the writer by Mr. E. A. Schwarz, who gathered them in the field at Baton Rouge, La., and Beeville, Tex., respectively.

June 6, 1909, Mr. D. K. McMillan sent some of this species feeding in the seed-heads of sorghum from Kingsville, Tex. About the same time he sent specimens of what he described as "pink larvæ," common under the shuck on corn ears, from Santa Maria, Tex. Later he sent more material from Kingsville, Tex., from which six adults were found on June 25, three on July 10, one on July 12, and more on July 13, 16, and 26. On June 20 he found this species working in corn in the husk at Beeville, Tex. November 9 of the same year the larva was again found in the heads of sorghum.

During 1912 specimens were received from Mr. M. M. High, Bureau of Entomology. On February 16 they were found working on corn. Seven living larvæ were placed in cornmeal and all died in two days.

During 1913 this species was received in dasheens (*Colocasia* sp.) from Mr. R. A. Young, Brooksville, Fla. The adults issued December 3 and continued to issue from the dry corms.

HISTORY AND LITERATURE.

Our early literature bearing on the biology of this moth, if we except line notices and brief mention,[1] is contained in the accounts of Townend Glover. In his first two entomological reports (Glover, 1855, 1856) its habits are described and the insect in its several stages figured. In the first article the species is treated under the name of "grain moth (*Tinea*?)"; in the second as the "corn worm (*Heliothes*?)." Afterwards in his Manuscript Notes from My Journal, or Entomological Index (Glover, 1877) the same writer refers to this species as *Tinea granella*, throwing the responsibility of its previous determination as "*Heliothes*?" upon D. J. B[rowne]. He found it in the cornfields of South Carolina and Georgia in September and says: "It infests the cornfields, where it is sheltered by the husks, and burrows between the grains, upon which it feeds, somewhat in the manner of the Angoumois moth, except that the kernels are more irregularly eaten," and that "these worms also appear to attack corn out of the field as well as in." Beyond this statement the writer is not aware that the insect has ever been mentioned as occurring in the granary, but from personal experience several years ago it was learned that it feeds upon the ripened corn and is perfectly capable of living indoors and that it unquestionably does so. Whether it is possible for the species to breed *ab ovo* in stored, i. e.,

[1] In the American Entomologist for May, 1880 (v. 3, p. 129), and again on page 121 of the appendix of the Fourth Report of the United States Entomological Commission, incidental mention is made of this species with the comment that, according to Chambers, it is a new species of Laverna.

dry, grain, it was at that time impossible to say. Glover also mentioned the occurrence of the insect in cotton bolls that had previously been pierced by the bollworm or split open by the rot.

In an article on the cowpea-pod weevil (*Chalcodermus aeneus* Boh.) the writer (Chittenden, 1904) mentioned the fact that the holes left in the pods affected by this weevil, which were formed by cracking or otherwise, led to secondary infestation by other insects. Among those reared during that year from cowpea was the species under consideration.

In a paper by Mr. E. S. Tucker published in 1911 (Tucker, 1911) mention of this species is made as follows: "Larvæ of this moth were frequently found in fallen bolls associated with and without *Araecerus fasciculatus* or its work. The larva is supposed to feed on insect remains." Again in the same article Mr. Tucker notes the finding of the same species at Alexandria, La., September 18, 1908, "in cornstalks infested by *Araecerus fasciculatus*, or where the latter had worked and left, and decay had begun," * * * "particularly in rotting, rain-soaked stalks"; the adults maturing in the breeding cage October 22–29. Mr. Tucker also reports that he found it "in green cornstalks, and sometimes in ear tips injured by the corn worm, *Heliothis obsoleta* Fab., at same place, August 2, 1909," and that "Mr. J. D. Mitchell submitted pupal cases taken from Araecerus cavities, in cornstalks at Victoria, Tex., March 7, 1909."

In his article on insects which affect the cotton plant, Dr. L. O. Howard (Howard, 1896) mentions this species in connection with its occurrence in young cotton bolls, and states that there was a general belief among planters that the species acts independently of cotton-worm damage. He added:

> This statement, however, has not yet been satisfactorily substantiated so far as it refers to the bolls. In the young squares, however, the active little reddish larva of this Batrachedra is very often found as unquestionably an original inhabitant, and it undoubtedly frequently causes quite an extensive shedding of the squares. This, however, occurs only in the spring, at a time when there is a surplus of bloom and when many squares can be spared without great reduction of the crop. Later in the season the Batrachedra larva is found boring in the unopened flower heads of various weeds.

The following year the writer (Chittenden, 1897) published some notes on this species, identifying Glover's corn-feeding tineid as *Batrachedra rileyi*.

In 1909 Mr. Otto H. Swezey (1909) repeats Walsingham's description and states that the larva was found in Hawaii feeding in various situations, most frequently on dead vegetable matter or refuse substances, and that therefore it was not particularly injurious. The larva was observed feeding beneath leaf-sheaths of dead cane; also in "borered" cane stalks in places where the leaves were dirty and sticky from the attack of aphides or leafhoppers. It was also found working in the tassels and very numerous in sweet-corn ears, feeding

on the "silks," inner husks, pith, and other parts of the cob; also in ears of field corn, eating into the kernels and cobs. At another time he observed it on a large woody twining bean vine, feeding on dying leaves and ripening pods, especially where there was an accumulation of webs and frass, or where other insects had been at work. Among other food plants he mentioned lantana, palm leaves, and the dead leaves of Pandanus, banana, and "various other plants." On banana the larvæ fed in the bunch on the dead or injured fruit and on the skin of the ripened fruit which they sometimes punctured, even eating into the fruit within.

ASSOCIATED INSECTS.

It has already been reported that this species usually follows the attack of the corn-ear worm (*Heliothis obsoleta* Fab. [Pl. I]), which is true of most other forms of stored-grain insects in the South. At about the same time the rice weevil (*Calandra oryza* L.) enters the corn but does not seem to work with the same rapidity as does the species in question. Later, in all probability, another species which is quite common, the square-necked grain beetle (*Cathartus gemellatus* Duv.) enters the ears and causes considerable damage both in the field and in store. This same insect is often found associated with the pink corn-worm in cotton bolls, and breeds in the same. The rice weevil occasionally enters cotton bolls, especially when they are on the ground, but does not breed in them, merely entering them for shelter or for hibernation. The Angoumois grain moth (*Sitotroga cerealella* Zell.) also breeds in corn with the species under consideration but thus far has not been found in many instances. It was observed at Agricultural College, Miss., in a sending dated November 28. The sorghum midge (*Contarinia sorghicola* Coq.) was also found associated with the pink corn-worm in sorghum seed from Brownsville, Tex., collected by A. K. McMillan, Nov. 9, 1909. A common moth ([*Nola*] *Nigetia sorghiella* Riley) was found in the same lot with the sorghum midge and it is probable that in this case the pink corn-worm followed attack of the Nigetia moth.

Among other associated insects are the foreign grain beetle (*Cathartus advena* Walt.) and the coffee-bean weevil (*Araecerus fasciculatus* De G.). The former is of comparatively little economic importance, feeding for the most part on stale grain, fruits, and other stored material, being naturally of a scavenging nature. Nevertheless, it has been quite troublesome during the past two years. The latter attacks coffee beans, mace, dried figs, and various other dried articles of commerce, and is also found somewhat commonly in diseased cotton bolls. A small ortalid fly (*Euxesta anonae* Fab.) was reared January 29, 1914, from dasheen (*Colocasia* sp.) affected with the pink corn-worm. This last species is without doubt a natural feeder on dasheen, but no record of its habits is available.

To show how severe is the injury wrought by the pink corn-worm, an ear of corn which has been infested only about 10 months is shown in Plate III. The larvæ were swarming under the husk, which has been removed to show the extensive webbing and injury to the kernels. For comparison with this is shown another ear of corn (Pl. IV) which was infested originally by the Angoumois grain moth and afterwards by the Indian-meal moth and rice weevil. At the time the photograph was made the Indian-meal moth had escaped, leaving its webbing. The latter ear weighs about twice as much as the former. The ear in Plate III was the best that could be found out of eight infested by the pink corn-worm, while that in Plate IV was picked at random to show the holes made by the Angoumois grain moth in escaping from the kernels and the extensive and peculiar webbing of the Indian-meal moth. In Plate III the pink corn-worm was still working in numbers, but in Plate IV neither of the moths mentioned could be found in any stage. While the ear in Plate IV had been held in store for two years, that in Plate III had been stored only 10 months.

NATURAL ENEMIES.

For some unexplained reason this insect appears to have few natural enemies, only one parasite having been reared. It is more than probable, however, that some predaceous insects, as well as bats and nocturnal birds, attack the moth when in flight in the fields and about the infested cribs. From larvæ received from Mr. E. A. Schwarz in cotton bolls gathered at Virginia Point, Tex., December, 1878, an ichneumon parasite issued March 3, 1879, and was identified as *Pimpla* sp. (U. S. D. A. No. 1041 P.°).

METHODS OF CONTROL.

Assuming that the damage in Mississippi and other States in the South is due largely to increased production of cotton and to the fact that it follows attack by the bollworm, it is suggested that if we could successfully combat the bollworm or corn-ear worm it should have a decided effect in lessening the numbers of pink corn-worm.

The corn should be gathered and husked as soon as possible, and the ears showing infestation by the pink worm should be fumigated immediately or fed to swine or poultry. This would prevent the infestation of other corn in store. Particular attention is called to this method of treatment since in some parts of the South it is customary to gather corn by "snapping" the ears, these afterwards being stored with the husks intact. This practice especially favors the development of certain grain-feeding pests, including the pink corn-worm. Moreover, the closeness of the husks renders successful fumigation by means of carbon bisulphid nearly impossible.

The additional handling incident to the husking process is also of benefit, as many of the larvæ are dislodged thereby, and the husked ears afford little concealment for pupation and for the feeding of the larvæ.

The best ears when dry could be saved to a considerable extent by placing them in an isolated weevil-and-mouse-proof fumigator such as a metal crib, to be made as nearly air-tight as possible.

CARBON BISULPHID.

In the South, where the pink corn-worm is so injurious, bisulphid of carbon is the best remedy and has already been used for its control. Carbon bisulphid, or bisulphid of carbon (CS_2), is a heavy liquid, colorless when pure, and is one of the standard chemicals for the control of insects injurious to stored products. Its value lies in the fact that it is extremely volatile, passing into the open air as a heavy gas which settles to the bottom of receptacles in which the liquid is exposed and, by replacing the air, causes suffocation. It is much used against the Angoumois grain moth and various other insects injurious to corn and other cereals. It is less poisonous to human beings than hydrocyanic-acid gas and, while there is danger from fire owing to its inflammability, with a reasonable amount of care this chemical may be cheaply and effectively applied to almost any stored product infested by insects.

It is more effective at a high temperature, 76° to 90° F. proving the best for its use. It is less effective under 70°, and not efficient as low as 50° F.

DIRECTIONS FOR USE.

Since carbon bisulphid is extremely volatile, it is best evaporated in flat vessels—milk pans, pie tins, and cheap plates serving this purpose admirably. An average application is 2 or 3 pounds to 1,000 cubic feet of air space, or 1 pound to 100 bushels. Less may be used, but it has been found that in a structure which can not be made positively air-tight it is necessary to use this amount to insure success. The liquid is poured into the evaporators, a half pint or more in each, and, as the gas is heavier than air, the evaporators are then placed in the higher parts of the bin or fumigator. Evaporating pans are frequently set on the top of the grain, allowing the gas to penetrate to the bottom, or, in the case of shelled corn, a perforated tube, such as a drive-well point, may be thrust into the grain and the requisite amount of the liquid poured therein.

When the gas is used in open bins or other receptacles the surface of the grain should be covered with heavy tarpaulin or canvas. The bin should be kept closed as tightly as possible for about 36 hours; this will not destroy the germinating power of the seed. With grains not desired for planting the bins may be allowed to remain closed as long as the gas evaporates.

EAR OF CORN FROM WHICH THE HUSK HAS BEEN REMOVED TO SHOW SEVERE INJURY BY THE PINK CORN-WORM. (ORIGINAL.)

CORN EAR SHOWING INFESTATION BY THE ANGOUMOIS GRAIN MOTH (SITOTROGA CEREALELLA) AND AFTERWARDS BY THE INDIAN-MEAL MOTH (PLODIA INTERPUNCTELLA). (ORIGINAL.)

The pink corn-worm and associated insect pests which have been mentioned enter the seed of grain in the field, so that treatment is most effective if made as soon as possible after harvest.

In the case of small quantities of seed a tight barrel may be used as a receptacle. One or two ounces of carbon bisulphid may be placed in a small saucer or pie tin upon the top of the grain and the top of the barrel covered with heavy cloths or oilcloth.

In the fumigation of a large building at least two, and preferably three, men should assist in the operation. The building should be tightly closed and the pans or containers for the liquid distributed about the building. Then, as far as possible, the work should be begun in the lower parts of the building, working toward the top. After the cubic capacity of the building and of the separate rooms has been computed, the requisite quantity should be divided among the pans in each room, about one pan to each 100 square feet of floor space being used. After the liquid has been poured into the pan the room should be left at once and the other parts of the building treated in the same manner. While the gas is not immediately fatal, it is well not to inhale too much of it, since nausea and severe headache are likely to result. After the building has been treated in the manner mentioned, exit should be made promptly and the doors tightly closed.

At the end of the period of exposure doors and windows should be opened wide so that the gas may escape. One or two hours should then elapse before work is resumed in the building. A slight odor may still linger in the poorly ventilated corners of rooms but there will be no danger to occupants from the gas, and the odor will gradually disappear with ventilation.

PRECAUTIONS.

Particular attention must be called to the danger from fire due to the presence of carbon bisulphid in the air, and special reference should be made to it in connection with the treatment of buildings.

The danger of bringing a lighted cigar or other lights, such as a lantern, into the presence of the gas must always be borne in mind, since in at least one case an explosion of considerable violence was caused by such carelessness.

The application should always be made in daylight, as no artificial light of any kind is allowable. Even electric lights may not be used, since there is always danger from the sparks caused by turning them on and off. Electric and other motors and steam pipes should be turned off, that no danger may result from the sparks or heat.

Owners of adjoining premises should be warned as to the character of the work that is being done and the need for care if vapor should penetrate their rooms to any extent.

It would be an added measure of safety if a watchman were kept on guard on the premises from the time the application is made until ventilation is complete. It would also be well to place large "DANGER" signs on the doors.

OTHER REMEDIES.

Among other remedial measures storage of corn in large bulk is recommended, since the surface layers of shelled corn or other grain are most exposed to infestation while the lower portions are not so apt to be injured, if at all. The larvæ could penetrate corn in the ear to a considerable depth, but, as their life is short, this is probably seldom done. The moths are unable to do so. Agitation applied to a mass of grain is also destructive to the moths, since they are unable to extricate themselves and perish in the attempt. Cold storage may be employed for valuable seed corn, and naphthalene balls may be used for the same purpose. The most scrupulous cleanliness should always be observed, much injury due to stored grain insects being directly traceable to disregard of this. Old grain and refuse material containing sweepings of grain, dust, dirt, and rubbish in general should not be allowed to accumulate and serve as breeding places for injurious insects.

In conclusion, it should be stated that promptness is absolutely necessary for the control of the pink corn-worm and that bisulphid of carbon can not be profitably used in open cribs, so that if this insect continues its ravages it may be necessary to construct special fumigating buildings and to store the corn in tighter receptacles than the cribs and bins now used.

SUMMARY.

1. The so-called pink corn-worm is not a true worm, but the caterpillar or larva of a minute moth known as *Batrachedra rileyi*.

2. Attack on corn begins in the field and continues after the corn has been stored. When the stored product is husked, the infested ears show injury by accumulations of webbing and frass or excrementitious matter. A careful inspection discloses the "pink worm."

3. The eggs are deposited in the field where the tips of the corn ears are more or less open, due to the attack of the corn-ear worm. After the latter has departed the pink corn-worm continues the injury and by its work makes it easy for other insects and water to enter the ears, which eventually are ruined.

4. From the cob or between the rows of grains the worm penetrates the kernels at the tip or point of attachment, works into the embryo or "germ," which it destroys, then outward to the crown.

5. Unlike the Angoumois grain moth and the rice weevil, which are usually to be found working in the same fields and frequently in

the same ears, this "worm" does not confine itself to the kernel, but attacks kernel, husk, and cob alike.

6. Also, unlike most other grain pests, it appears to be confined among cereals to corn and sorghum, although it attacks, but does not seriously injure, cotton bolls which are more or less open, and some other plants.

7. While thus far it has proved most injurious in Mississippi, it ranges from South Carolina westward to central Texas, southward to tropical Texas, and northward to Arkansas and Tennessee.

8. During the years 1914–15 the pink corn-worm was reported to have occasioned very considerable injury, and much alarm was felt because of its abundance in the regions mentioned. Previously, although known to attack corn, it has never been considered a serious enemy of grain.

9. Naturally it can not be foretold when, if ever, such an outbreak will recur.

10. As a preventive of injury, corn should be left in the field no longer than is absolutely necessary for drying it; the husks should then be removed as soon as possible, the poorest of the infested ears destroyed promptly or fed to swine or poultry, and the best ears fumigated with carbon bisulphid according to the directions given on previous pages.

11. The bins or cribs should be kept scrupulously clean, and should be fumigated before new material is stored in them.

12. Cooperation among corn growers of as large a territory as possible where the species occurs should be secured, that future losses may be prevented.

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